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*Study The Structural and Optical Properties of Silver Nanoparticles Prepared By Using Pulsed Laser Nd-YAG

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Abstract

Silver nanoparticles were prepared by using Nd-YAG pulse laser with (λ=1064 nm), and the optical properties of these nanoparticles were studied. Then the optical absorbance spectrum measurements in NaOH were carried out. Shape, size and concentration of the colloid silver AgNPs show a spherical shape and a particles diameters in the range of (30-50) nm. Finally, the spectral measurements such as surface plasmon emission (SPE) from the prepared silver nanoparticles were done.

Keywords: Nanomaterials, Nanoparticles, Silver, Nanosilver, Nd-YAG Laser

1- Introduction

Noble metal nanoparticles such as Ag and Au have been a source of considerable attention due to their novel electrical, chemical, physical, optical and magnetic properties [6]. However, design, synthesis, and fabrication of nanoparticles for specific applications or fundamental inquiry remains immature without accurate and well resolved characterization of nanoparticle size and structure [2]. Size-controlled optical properties of Ag-nanoparticles open good prospects for potential technological applications such as diffraction elements, optical filters, nanoplasmonic devices [4]. The structure , shape and size of nanoparticles produced by pulsed laser ablation of bulk target immersed in the liquid environment depends on several factors, including: the wavelength of the laser beam used, intensity, duration of pulses, ablation time and the effect of the surrounding medium with or without surface tension of the liquid [3]

***The Research is apart of on M.Sc. thesis in the case of the third researcher**

2- Experimental Works

Nd-YAG,Laser beam was focused by using lenses above the target metal. The target metallic silver (purity of 99.99%) was fixed by a holder at the bottom of a quartz container .Nd-YAG Laser with an output pulse energy in the range of (600-750) mJ and wavelength of (1064) nm were used as in figure (1). The absorbance spectra of prepaired AgNPs in NaOH was carry out using (UV-Vis) double beam spectrophotometer (CECIC7200). Scaning electromicroscope (SEM) images of AgNPs were investigated using SEM (INSPECT-550).

3- Results and Disscusions

Most of nanoparticles such as silver tend to cluster and agglomeration after the ablation process directly, so it is necessary to work to prevent the bloc to take advantage of the surface tension property of some liquids. We have used for that sodium hydroxide solution at various concentrations. The results showed that the absorbance greatly improved in the most of concentrations . This shows that the sodium hydroxide solution works to increase the production of silver nanoparticles.

Figure (2) and table (1) shows that the increase in the number of pulses lead to an increase in the intensity of the absorption spectrum, which is a testament to increase the density of the nanoparticles inside the liquid. The increase in the number of nanoparticles due to the fact that the laser beam works to uproot the amount of nanoparticles in each pulse and increase the number of pulses is working to increase the number of nanoparticles.

Figure (3) shows the absorbance spectra of AgNps sample, prepared at different laser ablation energies on silver plate placed on the bottom of quartz vessel containing 0.8 ml of sodium hydroxide solution. The results performed by keeping the number of pulses at 30 pulses and changing the energy of the laser beam in the range 600 mJ to 750 mJ. It can be seen from figures (3), and (4) and table (2) an increase in the pulse laser energy (600-700 mJ) the absorbance increased from 0.58 to 2.51 and the wavelength peak red shifted from 413 nm to 400 nm. This indicates the increase in the energy of the laser beam make it able to eradicate more particles. As well as, the increasing in the laser energy to (750 mJ) lead to decrease in absorbance intensity to (1.664) at the wavelength (414 nm). The explanation for that: when we increase the ability of the laser beam make it able to eradicate micro particles and not nano particles. We can deduce from all of the above that the presence of sodium hydroxide solution helps to increase the generation of silver nanoparticles. The abundance of silver nanoparticles is attributed to the presence of OH^- ions, which in particular increase the efficiency of the formation of AgNPs ; this fact was confirmed by Sylvestre [7].

Figure (5) shows the effect of NaOH concentration with a rate of (2 mM) to (10 mM); on the absorbance spectra of AgNPs. The results performed at number of laser pulse of (30 pulses) and laser energy of (700 mJ). According to our results, the optimum NaOH concentration to produce maximum amount of AgNPs is (2 mM) at laser energy and pulse number of (700 mJ) and (30 pulses) respectively .

Figures (6) and (7) showed a typical SEM image and EDX of silver nanoparticles prepared in NaOH**.** As can be clearly seen, no aggregation took place and the size distribution is narrow with an average diameter of (30-50) nm **.** In all

media as shown in SEM images, silver nanoparticles are spherical in shape. In this study the shift of the maximum of optical extinction is due to an increase in the size of the particles in the different environments. In addition, broadening of the extinction spectra in NaOH is related to the broad size distribution of the particles as confirmed by SEM images. These observations suggest that the size distribution and stability of nanoparticles depend on the nature of the surrounding liquid environments during ablation[5,8]. EDX spectra indicated well defined peaks corresponding to Ag and Si.

Table (4) shows the measured weight of silver which used, before exposure to laser pulses and after exposure, and also shows the weight loss. The results was fit perfectly with the number of laser pulses .

4- Conclusions

1- The absorption spectrum in a solution of silver nanoparticles quasi-symmetrically around the 400 nm wavelength showed that the nanoparticles in the solution be quasi-spherical volume of about diameter 8 nm, note that silver nanoparticles are pale yellow in color.
2- SEM images of silver nanoparticles showed a spherical in shape of Ag NPs. A broadening of the extinction spectra in NaOH is related to the broad size distribution of the particles . These observations suggest that the size distribution and stability of nanoparticles depend on the nature of the surrounding liquid environments during ablation.

References

1. Abdulrahman, A. , K., (2010) "Preparation of Ag and Au Nanoparticles by Pulsed Laser Ablation in Liquids " Eng. & Tech. Journal,Vol.29, No.15, 2010
2. Hassan Korbekandi, K., and Siavash Iravani (2012) " Silver Nanoparticles, The Delivery of Nanoparticles" (Ed.), InTech Journal, ISBN: 978-953-51-0615-9, p. 3-36 Available from: http://www. intechopen. com / books / the – delivery – of-nanoparticles/silver nanoparticles
3. Liu, P. , Liang, Y. , H.B. Li, G.W. Yang (2011) "Laser Ablation in Liquid : From Nanocrystals Synthesis to Nanostructures Fabrication " Nanomaterials: Applications and Properties (NAP-2011). Vol. 1, Part I , p. 133-135
4. N.V. Nikonorov, Sidorov A.I. and Tsekhomskii V.A. (2010). "Silver Nanoparticles in Oxide Glasses:Technologies and Properties" (Ed.), InTech Journal, ISBN: 978-953-307-028-5, p. 177-200 Available from: http : // www. intechopen. com / books / silver-nanoparticles/silver-nanoparticles-in-oxide-glassestechnologies-and-properties
5. Poondi, D. , Dobbins, T. , Singh J., " A novel laser-liquid-solid interaction technique for synthesis of silver, nickel and immiscible silver-nickel alloys from liquid precursors" journal of materials science 35 (2000) 6237 – 6243
6. Siekkinen, R., McLellan, J. M., Chen, J., Xia, Y., (2006) "Rapid synthesis of small silver nanocubes by mediating polyol reduction with a trace amount of sodium sulfide or sodium hydrosulfide"Chemical Physics Letters 432,491–496
7. Sylvestre, J. P. , Poulin, S., Kabashin, A.V., and Sacher, E., (2004) "surface Chemistry of Gold Nanoparticles Produced by Laser Ablation in Aqueous Media" J.Phys. Chem. 108 , 16864-16869

8. Tilaki, R.M., iraji, A. , zad and Mahdavi, S.M., (2006) "Stability, size and optical properties of silver nanoparticles prepared by laser ablation in different carrier media" Applied Physics AMaterials Science & Processing 84, 215–219

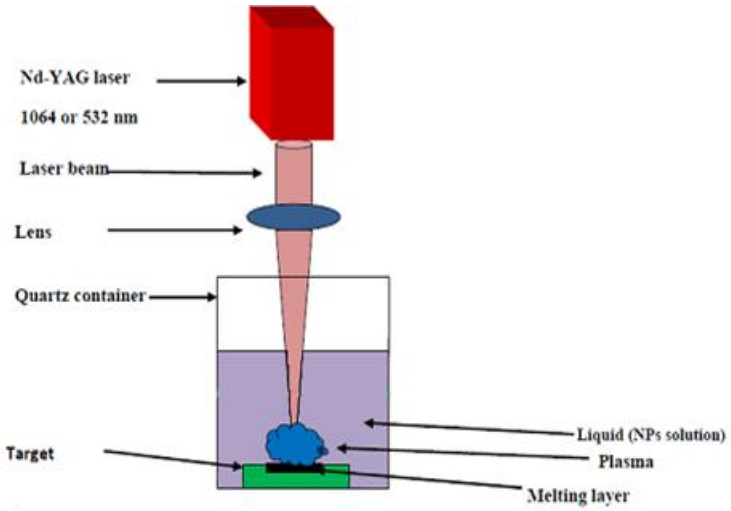

Figure (1)Experimental setup for nanoparticles synthesis, by laser ablation technique[1]

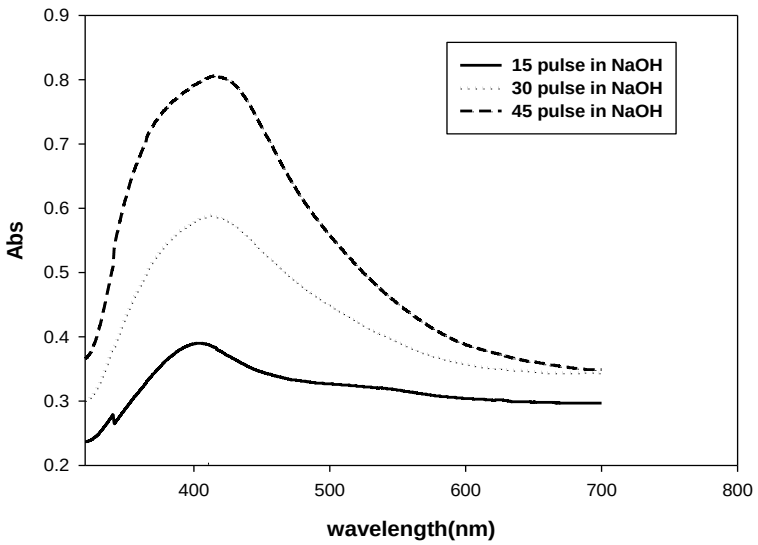

Figure (2): Absorbance spectrum of AgNPs for different values of number of pulses

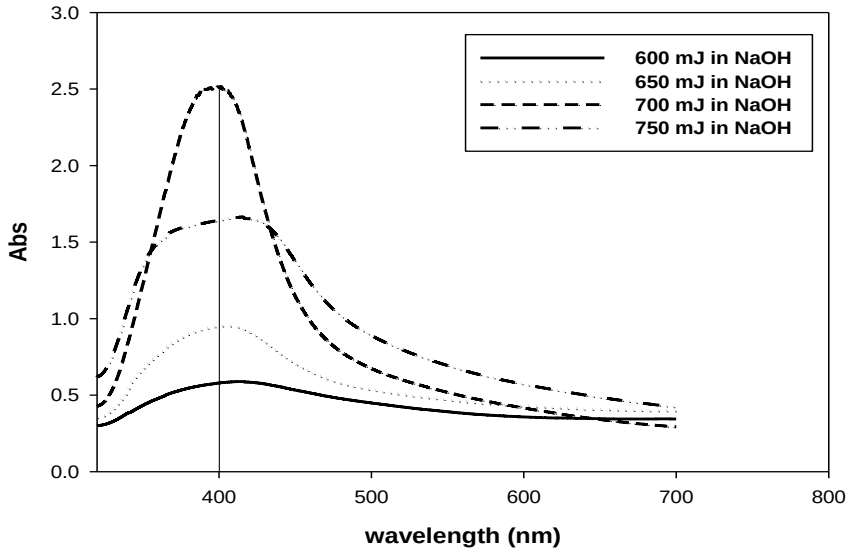

Figure (3): Absorbance spectrum of AgNPs for different values of the energy of the laser beam

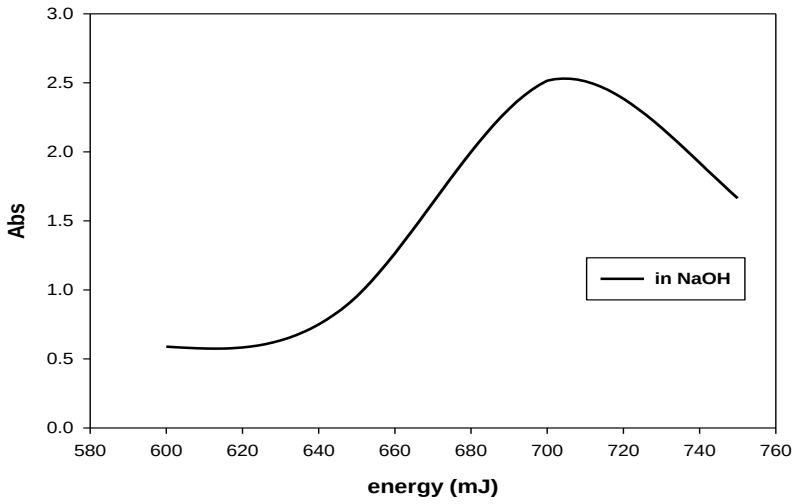

Figure (4): Absorbance as a function of energy

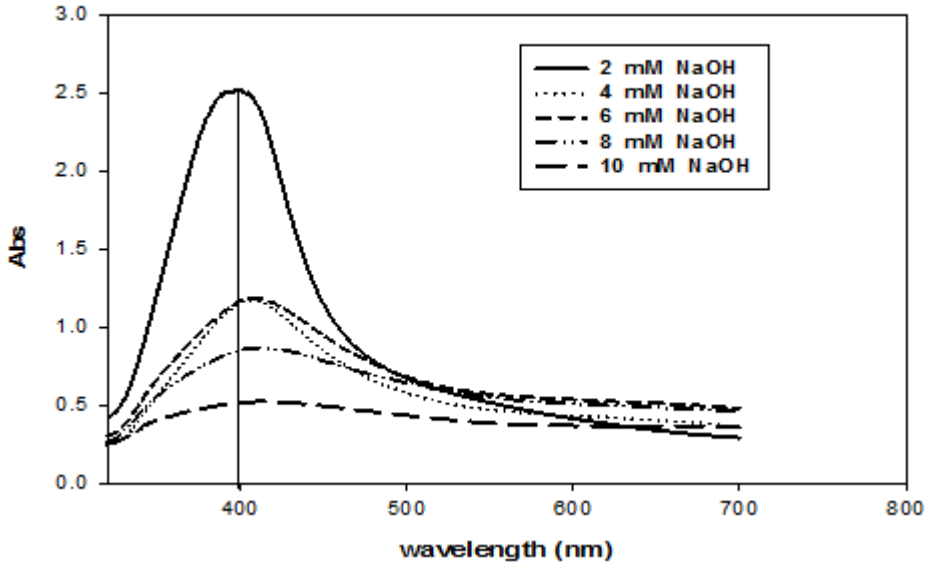

Figure (5): Absorbance spectrum of AgNPs for different values of the NaOH concentrations

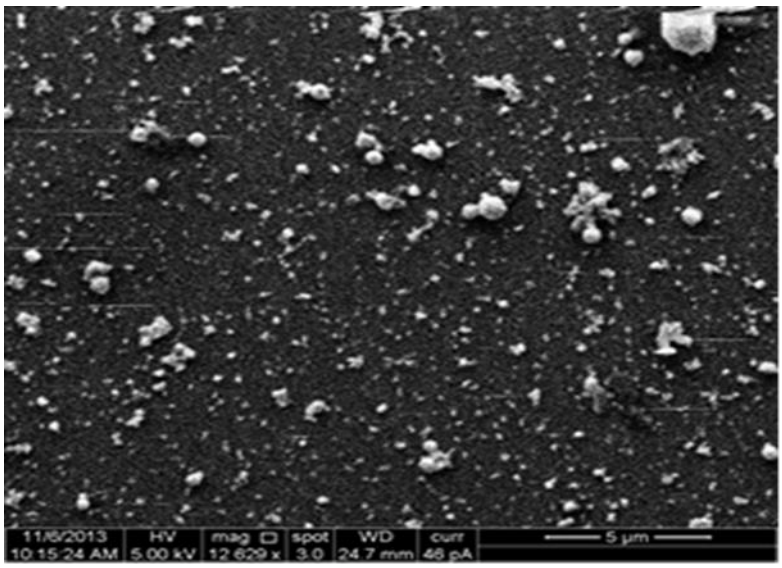

Figure (6): Shows the SEM image of Ag NP on silicon substrate

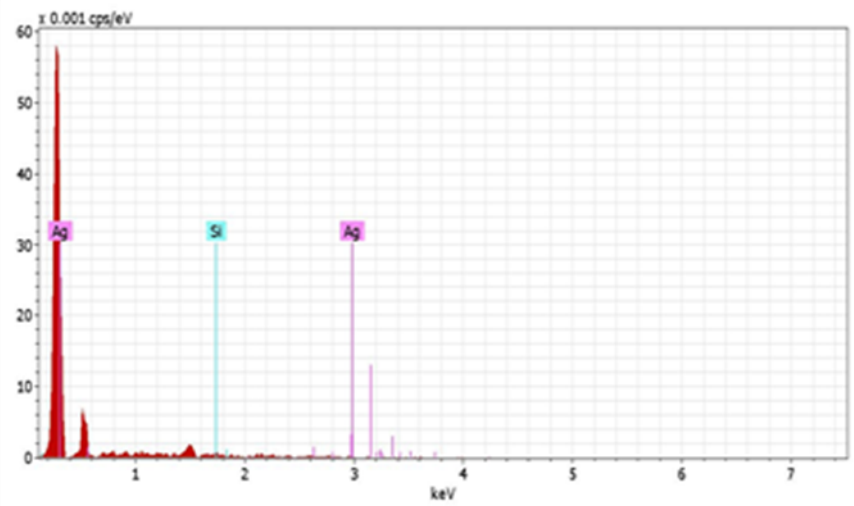

Figure (7): Shows the EDX chart of Ag NPs on silicon substrate

Table (1) Peak wavelength values of absorbance spectrum as a function of number of laser pulses :

No. of pulse	Wavelenght (nm)	Abs
15	404	0.39
30	413	0.589
45	416	0.807

Table (2) Peak wavelength of absorbance and transmittance spectrum as a function of energy of laser pulses:

Laser energy	Wavelength (nm)	Abs	T%
600 mJ	413	0.589	25.867
650 mJ	405	0.952	11.279
700 mJ	400	2.515	0.305
750 mJ	414	1.664	2.222

Table (3) Peak wavelength of absorbance spectrum as a function of NaOH concentration

NaOH concentration	Wavelength (nm)	Abs
2 mM	400	2.515
4 mM	407	1.173
6 mM	408	1.185
8 mM	412	0.869
10 mM	413	0.525

Table (4): Ag weight loss as a function of the number of laser pulses prepared in NaOH solvent

pulses	Weight before (gm)	weight after (gm)	weight lost (gm)
15	0.4407	0.4398	0.0009
30	0.3862	0.3848	0.0014
45	0.3677	0.3657	0.0020

*دراســة الخصائص التركيبية والبصرية لجسيمات الفضة النانوية المحضرة النبضي Nd-YAG باستخدام ليزر

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الخلاصة:-

تم تحضير جسيمات الفضة النانوية باستخدام ليزر Nd-YAG النبضي ذو الطول الموجي (1064) نانومتر. ودرست الخصائص البصرية لهذه الجسيمات. وقد أجريت قياسات طيف الامتصاص الضوئي في هيدروكسيد الصوديوم. وأظهرت دراسة الشكل والحجم وتركيز جسيمات الفضة الغروية أنها كروية الشكل وذات أقطار بحدود (30-50) نانومتر. وأجريت القياسات الطيفية مثل(SPE) لجسيمات الفضة المحضرة.

***البحث مستل من رسالة ماجستير للباحث الثالث .**